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REDESCRIPTION OF THE BURROWING SPONGE *ZYZZYA MASSALIS* (DENDY) FROM THE SEYCHELLES AND HOUTMAN-ABROLHOS ISLANDS.

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ABSTRACT

Massive, burrowing, fistule-bearing specimens of *Zyzzya massalis* (Dendy) are described from the shallow subtidal of the Seychelles Islands, Indian Ocean, and Houtman-Abrolhos Islands, Western Australia. This material represents only the second occurrence of massive morphs of this species, whereas all other records since the original description have dealt with thinly encrusting morphs. The species is also the first record for Australian waters, which now confirms its circum-Indian Ocean distribution. It is referred to the family Coelosphåeridae, and acquires the nominal species *Paracornulum atoxa* Vacelet *et al.* as a new synonym.

KEYWORDS: *Zyzzya massalis*, *Plocamia*, *Damirina*, Poecilosclerida, Coelosphaeridae, Porifera, marine sponges, Seychelles Islands, Houtman-Abrolhos Islands.

INTRODUCTION

Recent collections of marine sponges by the USSR Research Vessel *Akademik Oparin* in the western and eastern Indian Ocean produced specimens of a burrowing sponge originally described as *Plocamia massalis* Dendy, and previously known only from deeper waters off Zanzibar (113 m depth), Mauritius (200 m depth), the Seychelles (unknown depth), and also recently collected from Three Kings Island, New Zealand (55-110 m depth). Material redescribed here from subtidal waters of the Seychelles (20 m depth) and Houtman-Abrolhos Islands (18 m depth) represents only the second occasion in which the massive (? adult) growth form of the species has been collected. It is also the first time that the species has been recorded in Australian waters. There are several papers describing marine sponges from the Seychelles Islands (Wright 1881; Ridley 1884; Topsent 1893; Dendy 1916, 1922; Thomas 1973), but only one work pertaining to the Houtman-Abrolhos Islands sponge fauna (containing 48 species; Dendy and Frederick 1924).

The Director of the Pacific Institute of Bio-organic Chemistry, Professor Georgy Elyakov, and the scientists and crew of the RV *Akademik Oparin* are gratefully acknowledged for providing the senior author with an opportunity to visit and collect from various remote reefs along the western and north-western coast of Australia. Grants from the Sir Winston Churchill Memorial Trust and Australian Biological Resources Survey which enabled the senior author access to European collections are gratefully acknowledged, as are Miss Shirley Stone and Prof. Claude Lévi for providing access to their collections in London and Paris Museums, respectively. The following abbreviations are used in the text: BMNH, British Museum (Natural History), London; NTM, Northern Territory Museum, Darwin; MNHN LBIM, Laboratoire de Biologie des Invertébrés Marins et Malacologie, Muséum National d'Histoire Naturelle, Paris; PIBOC, Pacific Institute of Bio-organic Chemistry, Vladivostok. Methods of spicule preparation for light and scanning electron microscopy are described elsewhere (Hooper 1986).

SYSTEMATICS

Family Coelosphaeridae Hentschel

Coelosphaeridae Hentschel, 1923:102.
Cornulidae Lévi and Lévi, 1983:966.

Diagnosis. Poecilosclerida with excavating, burrowing or cryptic habits, and with specialized hollow, fistulose aquiferous systems. Skeleton usually consists of well differentiated (in structure or spicule composition, or both) ectosomal and choanosomal regions, both composed of diactinal megascleres (tylotes, strongyles, oxeas, or modifications), and which may form a tangential ectosomal crust. Microscleres may include arcuate and palmate isochelae, palmate anisochelae, sigmata, toxa and raphides.

Genus *Zyzzya* de Laubenfels

Zyzzya de Laubenfels, 1936:64 (type species *Plocamia massalis* Dendy, 1922:78, by original designation and monotypy).

Damirina Burton, 1959:240 (type species *Damirina verticillata* Burton, 1959:240, by original designation and monotypy).

Diagnosis. Coelosphaerids with verticillate-spined strongyles. Massive burrowing or cryptic encrusting growth form, with solid apical fistules or blind papillae. Ectosome consists of a thick detachable crust of tangentially orientated tylotes bearing microspined heads. Choanosomal skeleton contains irregular, widely-spaced multispicular tracts of tylotes ascending to the surface, between which is dispersed an irregular isodictyal reticulation of verticillately-spined strongyles. Microscleres, if present, are palmate isochelae.

Zyzzya massalis (Dendy)
(Figs 1-6)

Plocamia massalis Dendy, 1922:78-79, pl.14, fig. 5a-e.

Dendoricella massalis - Topsent 1928:64.

Lissodendoryx massalis - Burton 1935:400; Thomas 1973:32-33, pl.2, fig.4.

Zyzzya massalis - de Laubenfels 1936:64.

Zyzza massalis - Bergquist and Fromont 1988:56-57, pl. 23F.

Damirina verticillata Burton, 1959: 240-241, text-fig. 25.

Paracornulum atoxa Vacelet, Vasseur and Lévi, 1976:59-60, text-fig.38.

Fig. 1. *Zyzzya massalis*: Houtman-Abrolhos Islands specimen (NTM Z2891).

Type material. HOLOTYPE - BMNH 1921.11.7.67 (only fragment remains): Off Mauritius, Indian Ocean, 200m depth, 23 August 1905. Coll. Percy Sladen Trust Expedition, HMS *Sealark*, dredge. HOLOTYPE of *D. verticillata* - BMNH 1936.3.4.510: Pemba Channel, off Tanga, Zanzibar, 05° 04.9'S, 30° 13.2'E, 113m depth, 15 January 1934. Coll. John Murray Expedition, stn. 112, dredge. SCHIZOTYPE of *P. atoxa* - MNHN LBIM DJV 46: Sud Grande Passe d'Ifaty, off Tuléar, Madagascar, 5.5m depth. Coll. P. Vasseur, SCUBA.

Additional material. NTM Z2891 (fragment PIBOC): Base of an outer fringing *Acropora* reef, eastern side of Pelsart Islets, Houtman-Abrolhos Islands, Western Australia, 28° 51.6'S, 113° 52.5'E, 18-20m depth. Coll. J.N.A. Hooper, SCUBA, RV *Akademik Oparin*, 09 July 1987, stn. HA1 (no.48). PIBOC 04-216 (fragment only) (plus fragment in NTM): Northwest side of outer coral reef, D'Arros Islands, Seychelles Republic, 05° 24.47'S, 53° 19.14'E, 12-20m depth. Coll.

Alexsandr Katancev, SCUBA, RV *Akademik Oparin*, stn.38, April 1987.

Description. Shape: (2891) Subspherical (now cut in half), with at least one third of the base lying in a shallow burrow in soft sediment. The surface of the sponge in the basal region has embedded fragments of dead coral and rock; the upper surface tapers to a single short fistule at the apex, with a terminal sieve-plate of oscula; (216) fragment of massive subspherical sponge with a smooth detachable ectosome; fistules, if they were present, are now not intact.

Dimensions: (2891) 140 mm high from base to the apex of the fistule, 84 mm diameter at the base of the sponge; 75 mm diameter near the fistular constriction; fistule is 38 mm high and 31 mm diameter, of solid construction.

Oscula: Sieve-plate at the apex of the fistule is comprised of up to 10 exhalant pores, from 1-2 mm in diameter. No ostial pores were seen on the basal section.

Colour: Live colouration is dark brown (Munsell 10R 5/2), which fades slightly to grey-brown in ethanol.

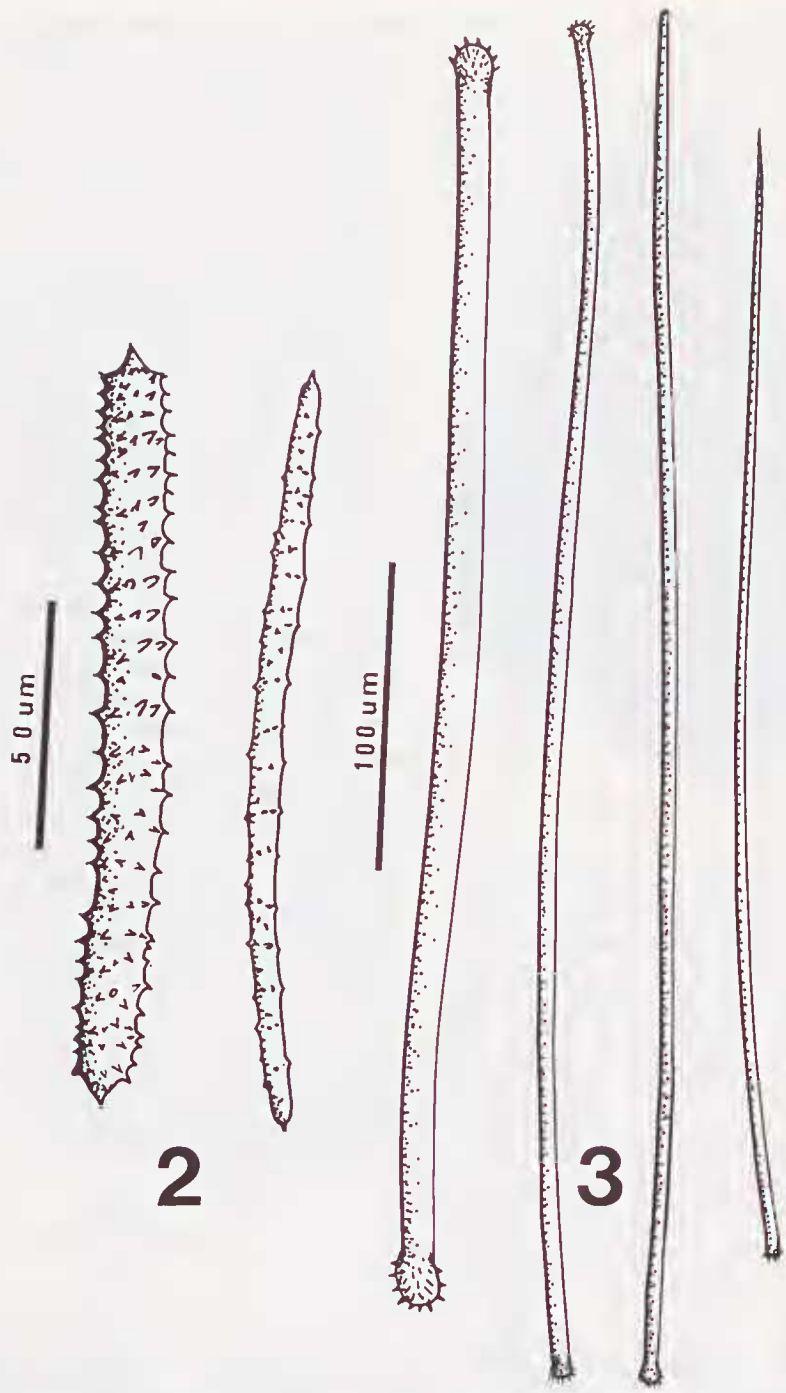
Texture: Sponge consistency is firm but compressible.

Ectosome: The surface is optically smooth, with a distinct skin-like covering which is detachable and easily damaged in preserved material. The ectosomal skeleton consists of a tangential layer of tylotes, through which are dispersed irregular paratangential tracts of acanthostrongyles. Spongin in the ectosomal region is relatively sparse, and slightly darker pigmented than in the deeper choanosomal region.

Choanosome: The choanosomal skeleton contains conspicuous plumose multispicular tracts of tylotes (90-230 µm in diameter), which meander, anastomose, sometimes form wide meshed reticulations (mesh sizes 240-650 µm), and vaguely ascend to the surface. Dispersed between these widely spaced tracts is an irregular unispicular subisodictyal reticulation of acanthostrongyles and occasional larger tylotes. In the choanosomal region of the fistule, juvenile raphidiform tylotes as well as mature examples are very abundant and dispersed between the acanthostrongyles, whereas in the choanosomal region of the base of the sponge the isodictyal reticulation of acanthostrongyles is much more dense. Spongin in the mesohyl is very heavy, dark brown pigmented and collagenous. Exhalant canals of the aquiferous system are elliptical, between 190x130 and 2350 x 640 µm in dimension. Choanocyte chambers are difficult to discern due to the heavy mesohyl spongin and dispersed spiculation, vaguely oval in shape and between 30-110 µm in diameter.

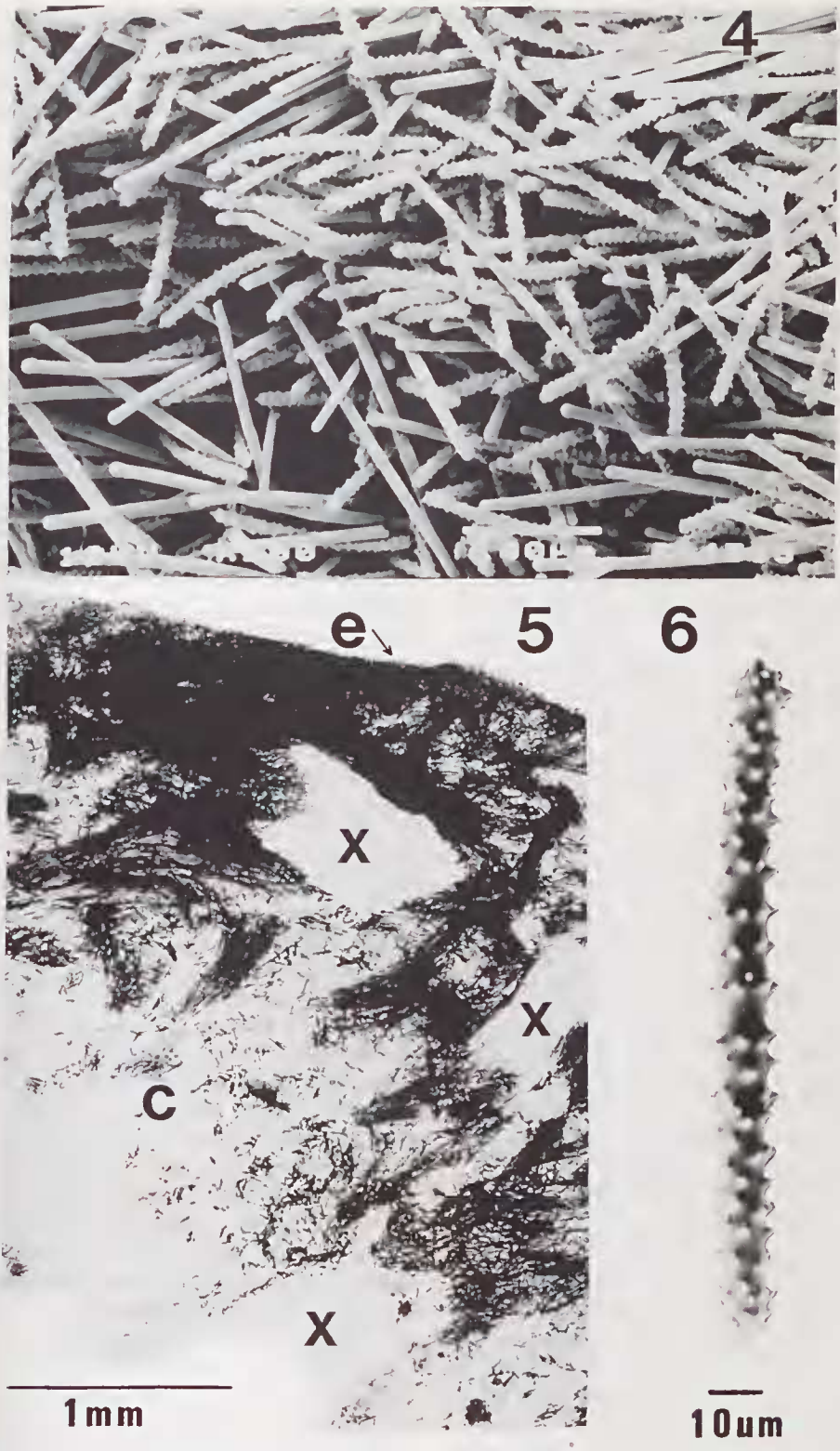
Table 1. Comparison between morphological features and spicule dimensions for specimens of *Zyzzya massalis*. Measurements are given in µm, and shown as range (and mean).

	Plocamia massalis Dendy 1922	*Damirina verticillata* Burton 1959	*Lissodendoryx massalis* (Thomas 1973)	*Zyzzya massalis* (Bergquist and Fromont 1988)	*Paracornulum atoxa* Vacelet et al. 1976	*Zyzzya massalis* (NTM Z2891)	*Zyzzya massalis* (PIBOC 04-216
Source	BMNH 1921.11.7.67	BMNH 1936.3.4.510	(fromThomas 1973)	(from Bergquist and Fromont 1988)	MNHN LBIM DJ46	present material	present material
Growth form	massive subspherical	encrusting in dead coral	thinly encrusting	thinly encrusting	encrusting and excavating dead coral	massive subspherical	probably massive
Colour	dark chocolate brown	dark brown	dark brown	dark red brown	brown	dark brown	brown
Fistules	short, apical, hollow	hollow	absent	absent	long, hollow	single solid, apical seive plate	(not seen)
Choanosome skeleton	dispersed multispicular tracts, and dense subisodictyal unispicular mesh	unispicular subisodictyal mesh	few tracts mainly confused isodictyal mesh	unispicular isodictyal reticulation, dense near the base	confused unispicular isodictyal	dispersed multispicular tracts, dense subisodictyal mesh	multispicular tracts, and confused subisodictyal mesb
Amphitylotes (apices)	286-(363.3)-408 x 6-(9.4)-14 (spined, some asymmetrical)	298-(374.4)-468 x 5-(11.5)-15 (spined)	222-260x4 (spined)	367-(385)-402 x 6-(9)-12 (spined)	180-(408.6)-590 x 2-(12.5)-20 (spined, some asymmetrical)	280-(381.1)-438 x 1.5-(8.2)-12 (spined, some asymmetrical)	305-(364.4)-418 x 3-(9.2)-12 (spined, some asymmetrical)
Acantho-strongyles	155-(171.0)-232 x 4-(10.8)-15	134-(193.5)-256 x 5-(16.1)-20	105-142x6	217-(241)-266 x 11-(12)-14	109-(209.1)-285 x 3-(11.8)-15	118-(162.2)-190 x 4-(11.1)-14	148-(197.7)-242 x 5-(12.2)-15
Palmate isochelae	14-(16.9)-20	absent	16	15-(16)-16	12-(17.0)-22	absent	absent
Locality	Mauritius	Zanzibar	Seychelles	New Zealand	Madagascar	Houtman-Abrolhos	Seychelles
Depth	200m	113m	unknown	55-110m	5.5m	18-20m	12-20m



Figs 2-3. *Zyzzya massalis*: **2,** verticillate acanthostrongyles, adult and juvenile form; **3,** tylotes, including styloid modifications of juvenile forms.

Megascleres: Tylotes are long, slender, often slightly curved, occasionally sinuous, with moderate tylote swellings at either end; larger spicules invariably have microspined heads. Juvenile forms occur also, ranging from much more slender varieties of the larger spicules, often with asymmetrical ends, to very thin raphidiform spicules with styloid modifications. Acanthostrongyles are generally symmetrically curved from the centre, with oxeote modifications in the form of a single terminal spine at each end, and with relatively even verticillate spination along the shaft, although juvenile forms of these spicules also



Figs 4-6. *Zyzzya massalis:* **4,** SEM tangential view of ectosomal skeleton; **5,** light micrograph of cross-section through fistule region (**c,** choanosomal region, **e,** ectosomal skeleton, **x,** exhalant canals); **6,** SEM of verticillate acanthostrongyle.

occur which have only vestigial spination. Refer to Table 1 for dimensions.

Microscleres: Absent.

Remarks. Both the Seychelles and Houtman-Abrolhos Islands material examined here lack microscleres. Furthermore, it was confirmed from a re-examination of Burton's (1959) holotype of *D. verticillata* that his observations were indeed correct: that his specimen also lacked isochelae microscleres, and these spicules were not merely overlooked as supposed by Bergquist and Fromont (1988). This infers that the species is prone to shedding its microscleres, since they are absent in 3 of the 7 specimens known so far. However, for the Poecilosclerida this observation is not unique (van Soest 1984), and certainly not an important criterion for differentiating the genera *Damirina* and *Zyzzya* (cf. Bergquist and Fromont 1988).

The precise gross-morphological details of the Seychelles specimen (216) is not known, since soon after collection it was divided up to provide material for biochemical analysis, microbiological assays, as well as a voucher specimen. However, from what remained of this specimen it was obvious that fragments came from a massive and not an encrusting specimen. (Similarly, only one half of the original Houtman-Abrolhos Islands material is now extant, the other portion was frozen and subsequently used for marine natural products investigations). Thus, the species appears to be relatively polymorphic in growth form, ranging from cryptic excavating to massive burrowing forms.

Three nominal species have been referred to *Zyzzya*: *Plocamia massalis*, *Paracornulum atoxa* Vacelet *et al.* and *Damirina verticillata* Burton. All three species have identical spicule geometry, including verticillately- spined acanthostrongyles. Skeletal construction is comparable also, despite the fact that *P. atoxa* and *D. verticillata* are only known from encrusting specimens. Contrary to arguments presented by Bergquist and Fromont (1988), all three species do have comparable and overlapping spicule dimensions (Table 1), and all have peculiar oxeote modifications to at least some of the acanthostrongyles (usually in the form of a single large spine at each end of the spicule). These features were noted from re-examination of type material. Bergquist and Fromont (1988) synonymised *D. verticillata* with the present species, and it is proposed here to merge *P. atoxa* with *Zyzzya massalis* also. The present record of the species from the Houtman-Abrolhos Islands confirms that the species has an oceanic-island, circum-Indian Ocean distribution, with a relatively extensive bathymetric range (5.5-200 m). The verticillately-spined acanthostrongyles present in *Zyzzya* are reminiscent of those seen in *Agelas* in particular (order Axinellida), but the two genera are not necessarily closely related in any other features.

Lévi and Lévi (1983) created the family Cornulidae for coelosphacrid sponges which have palmate isochelae microscleres, and this taxon has been recognised subsequently by Bergquist and Fromont (1988). Those authors are not followed here, since the criterion of whether isochelae microscleres are palmate, arcuate, birotulate or absent (presumably secondarily lost) cannot be considered to be of sufficient systematic importance at the family level of classification. This position is consistent with a similar treatment of other Poecilosclerida families (e.g. van Soest 1984; Hooper 1989, in press).

Nominal genera referred to Cornulidae by authors are: *Acheliderma* Topsent, *Astylinifer* Topsent, *Coelocarteria* Burton (including *Ichnodonax* de Laubenfels), *Cornulum* Dendy (including *Coelosphaerella* de Laubenfels, and *Cornulella* Dendy), *Cornulotrocha* Topsent, *Fusifer* Dendy, *Heterocornulum* Lévi and Lévi, *Paracornulum* Hallmann (including *Cornulacantha* Lévi), and *Zyzzya* de Laubenfels (including *Damirina* Burton). The family Coelosphaeridae *sensu* Bergquist and Fromont (1988) contains taxa otherwise similar to Cornulidae, but with isochelae that are not palmate. Genera included with this group by authors are: *Amphiastrella* Dendy (including *Xytopsene* de Laubenfels), *Coelodischela* Vacelet *et al.*, *Coelosphaera* Wyville Thomson (including *Coelosphaericon* Bakus, *Histoderma* Carter, and *Sideradermella* Dendy), *Damiria* Keller, *Histodermella* Lundbeck (including *Hiltonus* de Laubenfels, and *Histodermopsis* de Laubenfels), *Histodermion* Topsent, *Inflatella* Schmidt (including *Joyeuxia* Topsent), *Lepidosphaera* Lévi and Lévi, *Manawa* Bergquist and Fromont, *Phlyctaenopora* Topsent, and *Pyloderma* Kirkpatrick (including *Sideroderma sensu* Ridley and Dendy). Most of these genera, in

both nominal family groups should be re-united in a single family, Coelosphaeridae, although some are very closely related, possibly synonyms (e.g. *Pyloderma* may be a junior synonym of *Coelosphaera* (van Soest 1984), *Coelodischela* is close to *Guitarra* and *Tetrapocillon* (van Soest 1988)), some may be more closely related to the Myxillidae (e.g. *Histodermion*, *Paracornulum*) or Mycalidae (e.g. *Phlyctaenopora*), and others do not fit with the coelosphaerids at all (e.g. *Cornulotrocha*, *Astylinifer*).

The coelosphaerids as defined here appear to be relatively homogeneous, on the basis of their gross morphology and spiculation. The family contains taxa which typically have a fistulous aquiferous system, but it is likely that this fistulose habit is related to an ecological specialization for burrowing or excavating the substrate (van Soest 1984). This character is certainly not unique amongst the Demospongiae, and it is obvious that this specialisation has arisen independently in several other groups also (some Haplosclerida such as *Oceanapia*, *Siphonodictyon*; Hadromerida such as *Polymastia*, *Spirastrella*; Halichondriida such as *Ciocalypta*; Astrophorida such as *Monsyringia*, *Disyringia*; Bergquist and Fromont 1988). Consequently, van Soest (1984) proposed that the possession of fistules could not be used to define a phylogenetically useful family taxon, since it is not unique for the group. He tentatively suggested that most of the genera could fit with the Myxillidae. However, the gross morphological comparison between the fistules of the Coelosphaeridae and other groups may be misleading, when significant differences may exist in microstructure and spiculation (Bergquist and Fromont 1988). It is proposed here to retain the coelosphaerid family taxon, because this group of burrowing and excavating fistulose sponges appears to be monophyletic, on the basis of spiculation and skeletal evidence at least, although it is admitted that no unique discriminating characters are present other than the gross morphology.

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